Henning, Peter A.; Heberle, Florian; Fuchs, Kevin; Swertz, Christian; Schmölz, Alexander; Forstner, Alexandra; Zielinski, Andrea

INTUITEL - Intelligent Tutorial Interface for Technology Enhanced Learning

Thakkar, Dhaval [Hrsg.]; Brdiczka, Oliver [Hrsg.]; Trattner, Christoph [Hrsg.]: ProS 2014. Workshop on UMAP Projects Synergy. 2014, S. 3-6. - (CEUR Workshop Proceedings; 1181)

INTUITEL - Intelligent Tutorial Interface for Technology Enhanced Learning

Peter A. Henning[1], Florian Heberle[1], Kevin Fuchs[1], Christian Swertz[2], Alexander Schmölz[2], Alexandra Forstner[2], Andrea Zielinski[3], and the INTUITEL collaboration

[1] Institute for Computers in Education, Karlsruhe U of Applied Sciences, Germany
[2] University of Vienna, Austria
[3] Fraunhofer IOSB, Karlsruhe, Germany

Abstract. The EU FP7 project INTUITEL provides a novel adaptive learning environment, which is neither test-driven nor curriculum-based. Although based on ontologies, it extends these by an innovative concept of learning pathways and a subsequent ranking algorithm. The resulting environment is in line with pedagogical models and cognitive theories and will be integrated in five different market leading learning platforms.

1 INTUITEL Overview

Adaptive learning environments have reached a point where the underlying technologies and educational principles are mature enough to actually create a financial and didactic benefit on a larger scale. Although significant scientific progress has been made over the years [1–4], respective broad range solutions are just beginning to compete with established platforms. Existing systems for adaptive learning are either

- test-driven, i.e., making use of learner testing to identify knowledge gaps or learning styles, which are then used to create personalized learning pathways by hiding or adding sub-elements; or
- curriculum-based, i.e., relying on the a-priori availability of fixed, already heavily annotated course material, which makes it impractical for teachers to create new adaptive courses using their own material or material from other sources.

In contrast to these existing systems, INTUITEL[4] is controlled by (i) the learning behavior of its learners, therefore addressing and improving the learning experience and (ii) the intentions and educational experience of teachers, giving them the freedom to design their courses in different ways to customize them on their specific target audience. To this end, INTUITEL employs a layered set of ontologies:

- A Pedagogical Ontology (PO) as the broad pedagogical background knowledge and vocabulary to non-intrusively enhance learning material.

[4] INTUITEL = Intelligent Tutorial Interface for Technology Enhanced Learning, http://www.intuitel.eu, is funded in the 7th framework programme of the European Union (FP7-ICT-2011.8, Challenge 8.1) under grant no. 318496

– A second ontological layer, the Cognitive Map (CM), for a particular domain of knowledge. The versatility of this approach was shown by successfully creating four prototype realizations for the domains *General Didactics*, *Network Design*, *Computer Programming* and *Radar Basics* as well as a methodology for creating such maps.
– A third ontological layer, the Cognitive Content Map (CCM), which relates a particular learning content to the CM for this domain.
– A Learning Model Ontology (LMO), which defines additional attributes for the dynamic enhancement of CMs and CCMs with didactic aspects.
– As the foremost learner-specific layer, a Learner State Ontology (LSO), which is automatically generated from data gathered about the learner, reflecting his current state and behavior.

This hierarchy allows for a clean separation of a didactical model into macro and micro level learning pathways, differentiating between global strategies and local tactics [5]. Such a multi-level approach is also known in the GRAPPLE system [4], but there the ontological core consists of a user model.

2 Semantic Aspects of INTUITEL

The usage of ontologies for TEL has been suggested quite some time ago [6], most implementations use them to derive a partial ordering of Knowledge Objects (KO) along the simple sequencing specification of SCORM [7]. More advanced concepts of learning pathways have been discussed before, but concrete implementations so far are either prototypical or moving into the direction of a programmed learning environment [9]. INTUITEL moves beyond this, proposing an extension of the ontology based approach that takes into account more advanced characteristics of a learning pathway such as modular and/or nested composition [10].

We consider an *observed* learning pathway as a piecewise linear curve joining all subsequently reached cognitive positions in a multi-dimensional cognitive space[11]. Several different predefined learning pathways, each following a distinct didactical concept and described in the ontological hierarchy, are then compared to the observation. Deviations between the observed cognitive position and these predefined pathways may be used to provide metacognitive feedback to the learner. On this basis the INTUITEL system calculates a set of possible *next recommendable cognitive steps* along these various predefined learning pathways [12].

These are then ranked according to Didactic Factors (DFs), also defined in the ontological hierarchy to be (more or less) fulfilled by the knowledge objects presented to the learner We hereby distinguish hard criteria (like e.g. language, which must be spoken by the learner) and soft criteria (like e.g. media preference) to attribute a rank to each of these next recommendable cognitive steps [13].

3 Pedagogical Aspects of INTUITEL

INTUITEL provides a concise and clear recommendation to the learner within his ordinary LMS, but he may still decide to follow this recommendation or not. Depending on the situation, even a natural language dialog with the learner is carried out. While still following the AHAM meta-architecture [2], the system therefore deviates from a simple sequencing approach rather dramatically, opening a larger didactical space to learner and teacher and leading to a much higher flexibility of concepts [14]. Following our approach one may e.g. re-use the same course material for a course following the Inquiry Based Science Education (IBSE) paradigm [15] as well as for more traditional approaches.

The *freedom of choice* is considered one of the major advantages of self-paced TEL by the younger generation. In preserving this freedom, INTUITEL is targeted at increasing the acceptance of TEL on a broad scale. The teacher (or course engineer) hereby acquires a rather non-intrusive role, where he may anticipate learners of completely different type moving through the content. The system therefore is a novel application of the Theory of Planned Behavior [16] to man-machine interaction.

Moreover the integration of learner and computer actually may bee seen as a hybrid actor of the Actor Network Theory (ANT), partially deriving its skills from the learner and partly from the computer [17].

4 Innovation from INTUITEL

INTUITEL does not constitute a novel LMS, but is introduced via a flexible and openly specified interface into five different leading eLearning platforms (eXact LCMS[5], Clix[6], Crayons[7], ILIAS[8] and Moodle[9]) and already now has a huge potential user basis.

A newly developed SLOM format for the association of metadata with learning content allows to perform the semantic enhancement without impairing the usage of this content in non-INTUITEL systems. To this end, INTUITEL also provides a tool suite for editing and import from other formats into SLOM.

The metadata concept of INTUITEL also provides the basis for an innovative treatment of learning resources: Learning resources anywhere on the internet may either be linked together without touching them, or be imported into a SLOM file. It is therefore possible to create personalized courses in a *global* virtual repository, no need exists for collecting and assembling learning resources into a single real repository [18].

References

1. Brusilovsky, P.: Methods and techniques of adaptive hypermedia. User Modeling and User-Adapted Interaction, 6 No. 23 (1996), 87-129
2. De Bra, P., Houben, G., Wu, H.: AHAM: A Dexter-based Reference Model for Adaptive Hypermedia. In: Westbomke, J., Will, U.K., Leggett, J.J., Tochtermann, K., Haake, J.M. (eds): Proceedings of the Tenth ACM Conference on Hypertext and Hypermedia: Returning to Our Diverse Roots. ACM, New York (1999) 147-156

[5] cf. http://www.exact-learning.com/
[6] cf. http://www.im-c.de/en/
[7] cf. http://www.iosb.fraunhofer.de/servlet/is/4525/#
[8] cf. http://www.ilias.de/
[9] cf. http://moodle.com/

3. Aroyo, L., Dolog, P., Houben, G.J., Kravcik, M., Naeve, A., Nilsson, M., Wild, F.: Interoperability in personalized adaptive learning. Educational Technology and Society 9(2) (2006) 418
4. De Bra, P., Smits, D. van der Sluijs, K., Cristea, A.I., Foss, J., Glahn, C., Steiner, C.: GRAPPLE : Learning Management Systems Meet Adaptive Learning Environments. In: Pea-Ayala, A. (Ed.), Intelligent and Adaptive Educational-Learning Systems: Achievements and Trends, Springer (2013)
5. Swertz,C., Schmölz, A., Forstner, A., Heberle, F., Henning, P.A., Streicher, A., Bargel, B.A., Bock, J., Zander, S.: A Pedagogical Ontology as a Playground in Adaptive Elearning Environments. In: Horbach, M. (ed): INFORMATIK 2013: Informatik angepasst an Mensch, Organisation und Umwelt, GI-Edition Lecture Notes in Informatics (LNI), P-220 (2013) 1955-1960
6. Henze, N., Dolog, P., Nejdl, W.: Reasoning and Ontologies for Personalized E- Learning. Educational Technology and Society 7(4) (2004) 8297
7. Gaeta, M., Orciuoli, F., Paolozzi, S., Salerno, S.: Ontology Extraction for Knowl- edge Reuse: The e-Learning Perspective. IEEE Transactions on Systems Man and CyberneticsPart A-Systems and Humans 41(4) (2011) 798809
8. Janssen, J., Berlanga, A., Vogten, H., Koper, R.: Towards a learning path specifi- cation. International Journal of Continuing Engineering Education and Life-Long Learning 18(1) (2008) 77-97
9. Janssen, J., Berlanga, A. J., Koper, R.: Evaluation of the Learning Path Specification. Educational Technology and Society 14 (3) (2011) 218230
10. Swertz, C., Schmölz, A., Forstner, A., Dambier, N., Heberle, F., Henning, P.A.,Streicher, A. Burghart, C., Bock, J., Badii, A., de la Fuente, L., Parodi, E., Thiemert, D., Gal, E., Ronen, M., Zander, S. 2014: Lernpfadmodellierung mit der Webdidaktik für die adaptive Erweiterung von Lernmanagementsystemen. In: Breiter, A., Rensing, C. (eds.): Proceedings of DeLFI 2013, Bremen 2013, GI-Edition Proceedings Vol. 218 (2013) 277-280
11. Henning, P.A., Heberle, F., Swertz, C., Schmlz, A., Burgos, D., de la Fuente Valentin, L., Gal, E., Verdu, E., de Castro, J.P., Parodi, E., Schwertel, U., Steudter, S.: Learning Pathway Recommendation in Intelligent Tutoring Systems. Submitted to the DeLFI Conference 2014
12. Alian, M., Jabri, R.: A Shortest Adaptive Learning Path in eLearning Systems: Mathematical View. Journal of American Science 5(6) (2009) 3242
13. Kerkiri, T., Manitsaris, A., Mavridou, A.: Reputation Metadata for Recommend- ing Personalized e-Learning Resources. In: Proceedings of the 2nd International Workshop on Semantic Media Adaptation and Personalization (2007)
14. Swertz, C., Henning, P., Barberi, A., Forstner, A., Heberle, F., Schmölz, A.: Der didaktische Raum von INTUITEL. Ein pädagogisches Konzept für ein ontologiebasiertes adaptives intelligentes tutorielles LMS-Plugin. Paper accepted at the GMW 2014 Conference (2014)
15. Rocard, M.: Science Education Now: A Renewed Pedagogy for the Future of Europe, Report EU22-845, Brussels : European Commission (2007)
16. Ajzen, I.: The theory of planned behaviour: Organizational Behaviour and Human Decision Processes, Vol. 50 (1991) pp. 179
17. Latour, B.: Social theory and the study of computerized work sites. In Orlikowski, W.J., Walsham, G., Jones, M.R. and DeGros, J. (Eds.): Information Technology and Changes in Organizational Work. London, Chapman and Hall (1996) 295-307.
18. Henning, P.A., Heberle, F., Streicher, A., Zielinski, A., Swertz, C., Bock, J., Zander,S.: Personalized Web Learning: Merging Open Educational Resources into Adaptive Courses for Higher Education, Paper accepted at the PALE workshop for the UMAP 2014 Conference (2014)